RTBfoods Step 3: Participatory Processing Diagnosis and Quality Characteristics

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Ethics: The activities, which led to the production of this manual, were assessed and approved by the CIRAD Ethics Committee (H2020 ethics self-assessment procedure). When relevant, samples were prepared according to good hygiene and manufacturing practices. When external participants were involved in an activity, they were priorly informed about the objective of the activity and explained that their participation was entirely voluntary, that they could stop the interview at any point and that their responses would be anonymous and securely stored by the research team for research purposes. Written consent (signature) was systematically sought from sensory panelists and from consumers participating in activities.

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1. STEP 3 OBJECTIVE

The objective of the Step 3 is to conduct participatory processing diagnosis of the crop under study with processors to understand their demand for quality characteristics of the crop, while processing different root, tuber and banana (RTB) varieties with various technological properties.

This Step 3 will identify the key processing unit operations important in the quality of intermediate and final product, and will produce products with different quality characteristics and sensory properties that will be part of the Step 4 consumer testing.

The manual also provides some guidance on gender-related evaluations that can be conducted outside of the time of the participatory processing diagnosis. Demand questions can be tailored to the processing centre at small town level using the Step 2 Market Interview questionnaire.

Please read the document in conjunction with Step 2 (https://doi.org/10.18167/agritrop/00569) and Step 4 (https://doi.org/10.18167/agritrop/00571) guidance documents.

2. STEP 3 OVERVIEW

This Step 3 involves a Food scientist-led team to evaluate the processing ability of different RTB varieties with a group of processors in the community during processing of the RTB crop into the product. Several parameters will be measured at each step of the process to assess the technological properties of each variety. This will involve participatory demonstrations and consultation with the processors to collect their opinions and views on the different quality characteristics of varieties, associated with the different processing steps or practices.

In order to identify the quality characteristics of the crop required at the processing level, it is necessary to have the greatest variability of raw materials (crops) to get final products with a large range of sensory characteristics. This variability will be obtained by processing local varieties (endogenous variability) known for their ability (or unsuitability) to give a high quality product. To increase the variability between sensory properties of the products, we may ask processors to process new genotypes with very different characteristics, compared to local varieties and unknown by the processors (exogenous variability). Variability may also be obtained by asking processors to significantly change processing conditions at a key step of the process to purposely obtain (or cause) a difference in quality.

The objective is not specifically to compare new genotypes and local varieties regarding their technological properties. Rather the objective is to propose a large variability of products to invite processors (Step 3) and consumers (Step 4), to tell us what their sensory preferences are – that may or may not include new genotypes. Comparison among a broad variability makes it easier for people to perceive and talk about their sensory preferences. For example, if the surveys in Step 2 determined that a good gari is very fine and very dry, we may ask processors to reduce (for one local variety) roasting time or/and conduct the sifting with larger opening sieves, in order to get gari with humid core granules or/and coarser particle size. This product will be described by processors at the end of the processing diagnosis by other (i.e. different, new) sensory characteristics which will be added to the list of characteristics already cited in Step 2, in view of determining those related to consumer overall liking when tasting the final product (Step 4 consumer testing).

During processing, facilitators will observe and discuss different aspects of product processing with processors. Specific actions include:

- Probing on the quality characteristics of the crop related to a high and low quality product at each step of the process.
- Undertaking a diagnosis of the process, and measurement of all the technological parameters such as weight of the crop (raw material), weight of the intermediate and final products, duration of each processing step, pH, and cooking temperature.
- Assessing the quality characteristics of the final products and giving their views on their preferences.
- Collecting samples of raw material, intermediate and final products at each step of the process to measure the dry matter content, for establishing a precise material balance of the process.
- Collecting the products for Step 4 consumer testing.
- Some samples of the final products may be kept or frozen for future analysis by biochemists who would like to translate for breeders these quality characteristics into physicochemical compounds.

3. EXPECTED OUTPUTS

The expected output is a report summarising the findings based on agreed format and templates. Reporting for Step 3 will need to include:

- Diagnosis of the RTB crop process into the product, to build the general diagram - flowsheet.
- Identification and characterisation with processors of the key processing unit operations important in the quality of the final product.
- Analysis and evolution of all the parameters measured all along the process (e.g. yield, pH, duration, and cooking temperature) for each variety.
    - Comparison of the data between varieties, between processors in a same location, and in other fieldwork sites with different processing conditions.
    - Comparative table of processing parameters obtained by processors in the processing centre for each variety.
    - Evaluation of the relative importance of processing conditions vs varietal effects on the yield and other processing parameters.
    - The sample size is limited but the objective here is to understand if the processing conditions or the variety has a major impact on the quality.
    - In addition, where possible, indication of the optimal range of some parameters (such as yield, pH) important in the quality of the product.
- List of crop quality characteristics required by processors at each step of the process to give a high quality product, including product variations. Importantly, the report should include the number of times the quality characteristics were cited in one location to compare across fieldwork sites.
- List of quality characteristics (most liked and least liked) of final products cited by processors after the processing diagnosis, when looking at, touching, and tasting the products, with a number of citations per characteristic for each product/variety.
- Overall preference ranking of the different products produced.

Step 3 will also result in the physical output of final products with different sensory characteristics that will be tested by consumers in Step 4, and the second stage of the product profile (the first being from Step 2).

A template for reporting will be provided. Suggestion for diagrams for the report are provided in Appendix C: Examples of diagrams for reporting, and for a table in Appendix D: Quality characteristics of the crop and the final product [under study] required by processors.

4. GUIDANCE

4.1. Drawing on the information from Step 1 (State of Knowledge) and Step 2 (Gendered food mapping)

Step 1 and Step 2 will provide information that will help to:

- Understand the context of the study, related to the crop and product.
- Provide a list of important characteristics and indicators of the product (for men, women and by region), that can inform the types of varieties to be used during the Step 3 processing diagnosis.
- Processors involved in Step 3 are also be able to propose local varieties (good ones and low ones) to which we can add a new genotype not yet adopted to increase the variability in quality characteristics and technological properties.
- Inform the selection of the sample locations. Refer to section 4.2.
- Identify a group of processors who are actively involved in commercial processing of the product and well known for making a high quality product in the area. During Step 2, community members will be asked to introduce processors reputed to make a high quality product, having the facilities (place, adequate cooking equipment to process several varieties at the same time, available operators…) for the participatory study and understand study objectives. Facilitators will invite them to participate to the study. Processors should reflect the diversity of the community e.g. ethnicity, wealth status, gender – depending on what is most relevant to that community. Processors using different processing and product variations may be also solicited for the study.
- Start to understand the quality characteristics of the crop and product under study required by each type of stakeholder (producers, processors and consumers), and compare it to the list of characteristics (disaggregated by gender, region) identified during Step 2.
- Help in the choice of local varieties (and improved varieties or new genotypes) representative of the large range of the quality variability of the crop in the area: varieties suitable to make a high quality product and varieties not suitable to make a high quality product, according to the different interviewed stakeholders. Locally some varieties are preferred for one product, others are very liked for another product and not really suitable for the 1st product. Processors know very well the local suitable varieties and non-suitable varieties for a specific product.
- That is the reason why there are specific raw material characteristics for one high quality product.
- Develop or adapt questionnaires for interviewing processors during the processing activities.
- Target the technological characterisation of some key processing unit operations critical in the quality of the product.
- Identify the main types of product with different quality characteristics (product variants) and select locations in the sample area that will be characterised during Step 3.

4.2. Prior to processing demonstration with processors

- Among processors identified in Step 2, select processors that have a recognised expertise in processing the product in the locality, with one key person who will be able to speak in French or in English to understand clearly the research team request. They should be motivated to participate in the processing diagnosis and be available during the period.
- Ensure that the level of technology of the processing unit is similar to the local average level of technology of most of the processing units in the sample area. Avoid selecting a processing unit that is not representative of main processing units in the area, such as for instance a very small unit or a large-scale processing plant.
- Quickly evaluate the quantity of the crop processed in that processing unit by period (month / week– drawing out differences by season if applicable ...) and the type of market targeted (retail, wholesaler, town, village etc.).

- Meet the group of processors in advance, to present the project, explain the objectives of the project and processing diagnosis, get their written/verbal consent, and visit their processing facilities (place, equipment, number of skilled operators…).
- Determine with them, and document the different steps of the process, their description, the duration of each step and the duration of the whole process.
- For **boiled products or pounded products** (cassava, plantain, yam), try to find processors who prepare these products in a cantina, or a restaurant or in the market, and for whom the preparation of these products is part of their job.
- Evaluate with processors the cost of the participatory study, the number of operators available and required for the study. Processors will be remunerated for conducting the processing of the crop into the products.
- Inform processors how the research team will conduct the activity and ask them if they have questions, suggestions or concerns about the participatory study. Adapt to the context when possible.
- Ask if they consent to participate and inform that all participants need to sign or provide their verbal consent (if illiterate) on the day of the processing diagnosis (Appendix E for Consent Forms in English and Appendix F for French).
- Get processors' help in the choice of 4-6 local varieties that reflect different characteristics identified in Step 2: for instance two known in the area as suitable for making a high quality product, two known as unsuitable for making a high quality product, and two others, intermediate in quality.
    - If the choice is limited, ask the processors to add 1-2 new genotypes from a research station close to the area to increase the diversity. Even if the agro-climatic conditions are different from the ones for the local varieties, the new genotypes will bring the variability required to understand well the quality at each step of the process, and to produce products with very different quality characteristics for Step 4 consumer testing. **The objective here is to have a large variability among the quality characteristics of the raw material to reveal significant differences in processing ability and the product quality.**
    - Processors will be able to provide very good local varieties and not-suitable varieties for making the product. If we add one or two genotypes grown by a farmer who is working with the local NARS, this will add variation in the quality of the final product (probably intermediate or low quality and why not high quality for the genotype). At the end, we will have three different types of product in terms of quality: high, low, and intermediate.
    - If there is a difference in quality characteristics between early maturing and late maturing crop under study, take this character into consideration in the selection of varieties for processing diagnosis. For instance, if a cassava root is harvested too early, it can be rich in fibres, whereas if its physiological maturity is reached it will contain few fibres and will be better accepted by processors.
- Collect information on agronomical characteristics of the local varieties chosen for the study (variety name, age/maturity, yield, etc.). Names of varieties are sometimes misleading.
- Request the quantity of crop required for the processing diagnosis. Depending of the yield of the product, calculate the supply you need for each variety to get the quantity required (in one batch) for consumer testing (Step 4). The product may be tasted raw, cooked into paste, or boiled.
    - The consumption pattern chosen for Step 4 will be defined in Step 2, as the most frequent consumption pattern of the product. The quantity of product needed for one test is around 30-50 g per consumer.
    - If the product is consumed cooked or with water added, determine with processors the ratio product/water to calculate the quantity of the raw product you need to produce with processors during processing diagnosis, and then the quantity of "ready to eat" product for consumer testing (Step 4).
- Define with processors the best period for harvesting the crop and for the processing diagnosis of the crop, to be present with them.

- Harvest enough of the different crops (local varieties and if necessary, new genotypes) for making the quantity of each product to be tested by a large number of consumers in each sampling area (Step 4). Each product should be provided from the same batch for consumer testing in the sampling area.
- Plan all the activities.
- Prepare all the logistics.
- Double check with the processors that everything is on track a few days before the processing diagnosis.
- Prepare a detailed experimental plan (Appendix B as an example) with data collection.

- If possible, depending of the team and some additional budget, team may sample the leaves just to store dried for genotyping. With current quick and cheap genotyping costs, it may make sense to at least sample and store with easy methods, then analyse.

Research team:

- Food scientist.
- Gender specialist and economist can join the demonstration for observation, but conduct separate interviews with the appropriate questionnaire on another day and time convenient to processors so as not to absorb too much time for the processors.
- Interpreter for local language (e.g. students in food science able to understand technological and sensory terms).

Location:

- Select 1-2 activity locations. Note that it may (or may not) be appropriate to conduct this Step 3 in the same locations as Step 2. If in your sample region, there are processing centres slightly larger than the rural village level in small to medium sized towns, we recommend conducting processing diagnosis at these processing centres, ideally close to the villages where Step 2 took place (Refer to the Tables 1 and 2).
- Concerning the short processes (boiled products like yam, cassava, sweet potato, potato or plantain; or pounded yam; or fried plantain; or matooke), the objective is to conduct 8 diagnoses corresponding to 8 different processing centres. Ideally, 4 diagnoses will be conducted in each region, in one or two small towns. If Step 2 did not identify significant differences between the process pathways in the two small towns within a same region, it will be possible to conduct the 4 diagnoses in only one small town (Refer to Figure 1).
- Concerning the multi-step processes (gari-eba, attieke, fufu), the objective is to conduct 4 diagnoses, each one in a processing centre based in one small town (two small towns per region). If Step 2 did not identify significant differences between the process pathways between the two small towns in a region, it will be possible to conduct 2 diagnoses in only one processing centre in one small town of the same region (Refer to Figure 2).
- The decision for the implementation of the processing diagnosis in one or two small towns of a same region will be possible by analysing Step 2 data related to the following questions: FGD Q.12 & Q.13 and MI Q.14.

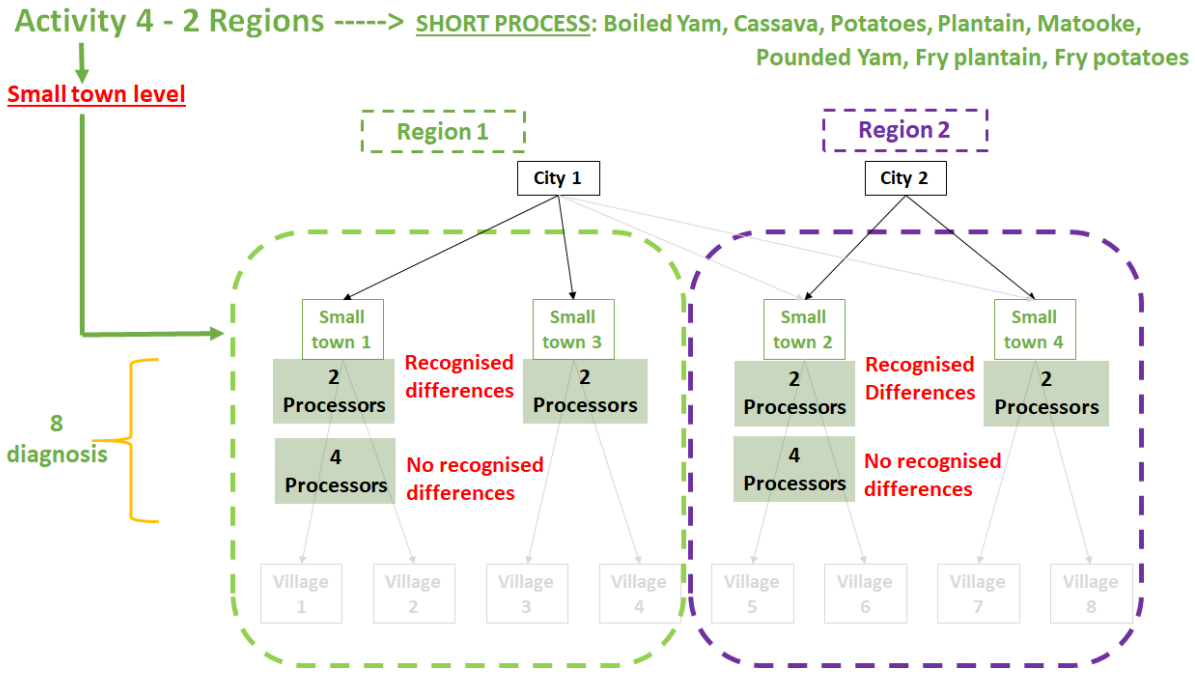


Figure 1: Step 3 sampling for short processes

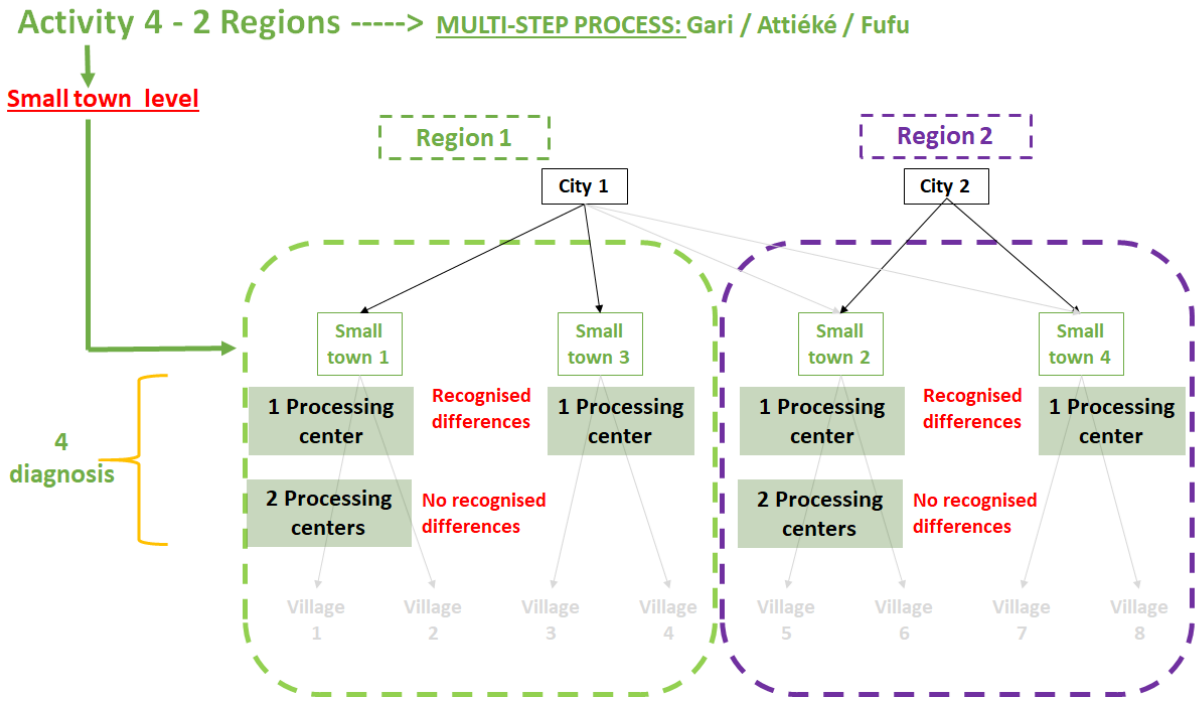


Figure 2: Step 3 sampling for multi-step processes

Table 1: Step 3 sampling in small towns/secondary centres

Total Number	Explanation
• Processing diagnosis in 2 – 4 small towns (1 – 2 per region)	• Purposively select 2 - 4 small towns. If the study is focusing on two regions, it would be advisable to select two processing centres per region for the processing diagnosis. • If processing centres are not relevant for your [product under study], purposively select 2-4 villages for the processing diagnosis. • Recruit processors for processing diagnosis, particularly people who are known in the community for making a high quality [product under study].
• Individual interviews with processors before, during and after the progressing diagnosis	• Individual interviews with processors who participated in the processing diagnosis on quality characteristics of crop and product. • To avoid tiring processors during processing diagnosis, ask if the processors could be interviewed on another day and time convenient to them for additional questions on gender demand.
• 4-8 Market Interviews (MI) (2 interviews per centre)	• As these interviews are not with processors, they can be conducted at any time convenient for the researcher and respondents. • Purposively select – e.g. leader of a wholesale trader association or market management that deals with the crop/ [product under study]. • Where possible, try to interview equal numbers of men and women.

Table 2. Sampling criteria for villages and towns (small towns/secondary centres) for Step 3

	Village	Small town / secondary centre
Population	< 5,000	~ 10,000 – 100,000
Processing centre **(for selected product, e.g. gari)**	No Only a bit of village processing of products	Yes, mostly small and medium enterprises (SMEs)
Other industries	No	Some SMEs (e.g. carpentry workshop)
Existence of markets	Small, and only on a weekly basis Perhaps one or two traders live in village who aggregate produce	Permanent medium or large-sized market, not only along roadside but also in designated market area
Other infrastructure	Perhaps primary school, and small church or mosque	May have hospital or health centre; secondary school, church, mosque

4.3. Participatory diagnosis of the process with processors: characterization of processing unit operations and measurement of several parameters

- When everything is ready regarding the logistics, informed consent forms are received, and when the minimum 4-6 varieties (or more) have been harvested in sufficient quantity, invite processors to observe each variety and give their views on the quality characteristics.
- Use the guidance in Appendix A: “Discussion guideline with processors before, during and after processing” to interview processors before starting the processing diagnosis. Please refer to 4.4. Discussion guideline with processors.
- Try to interview a group of 5-8 processors -- those who will be involved in the processing diagnosis of the crop.
- Prior to the first stage of the processing process, the research team should weigh the supply of each variety (raw material) selected previously, and that will be processed by processors into the product under study.
- Then processors are invited to start the processing of the 4-6 (or more) varieties selected previously. The processing will be carried out in real/normal conditions with processors. Each processor will start with the first unit operation stage, taking in charge one variety.
- At the end of that stage (for instance crop peeling), the research team will weigh the intermediate product (peeled crop) and losses (peeling losses: what was removed by processors as peels and other, such as tips). The duration of that unit operation is also measured.
- The small equipment recommended for that is : chronometer and balance / load cell
- If 8 varieties have been selected and only 4 processors are available to process the product, each processor will move on a second variety when the first unit operation has been completed for the first variety. At the end of the first unit operation for each of the 8 varieties, processors move on the second stage of the process with their first variety and then with their second variety, and so on, until the end of the last unit operation when getting the final product.
- At the end of each unit operation, the research team weighs the intermediate or final product, losses, and duration of the unit operation. Samples of intermediate and final products are collected to measure the dry matter content for establishing the material balance.
- For some specific unit operations such as fermentation, the research team may also measure the **pH**, or for unit operation such as roasting, **temperature** of the cooker may be recorded all along the cooking operation.
- Each processing unit operation and then the whole process will be characterised by calculating:
  - The **yield** which is defined as the quantity of processed product in percent (wet basis) of the quantity of raw material.
  - The **material balance** may be evaluated by measuring the weight of all the inputs (crop, water…) and the outputs (final product, peels, fibres, waste water…), and checking that the weight of inputs and outputs are balanced. Material quantities that go into the process must go out, with conservation of mass. Dry mater of all the collected samples will be measured and the material balance will be based on mass of dry materials.
  - The **productivity** which is defined as the quantity of raw material processed by hour and by processor. It is expressed in kg of processed raw material/h/operator.
- The key unit operations identified as critical for making a high quality product will be the most instrumented. The measured parameters will be important to understand their “optimal range” to give a high quality product.
- For **boiled products or pounded products** (cassava, plantain, yam), the process is very simplified and includes only 2-3 unit operations such as peeling, washing, and boiling or pounding. In that case, the parameters measured will be: peeling yield, peeling duration, boiling or pounding duration, and productivity of each unit operation.

- It is advised to duplicate the processing diagnosis for each variety with significant quantities of raw material in order to collect representative data. If this is the case, the final product may be mixed to be tasted by consumers in Step 4.
- At each step of the processing, processors are asked on what details they recognise that the crop (or the intermediate product) will give a high quality product, and how they know if the variety is suitable for that processing. Please refer to 4.4. Discussion guideline with processors.
- At the end of the processing diagnosis, processors are invited to assess the quality characteristics of the different final products. Please refer to 4.4. Discussion guideline with processors.

Equipment

The table below shows an example of the main field equipment required to characterise each unit operation during processing of cassava into gari.

This list of equipment is not exhaustive.

Table 3. Parameters measured and main field equipment required for characterising each unit operation during processing of the crop into the product under study

Unit operation	Parameters measured	Equipment
Peeling	• Yield (peeled crop weight/crop weight)*100 • Productivity (kg of processed raw material/h/operator)	• Chronometer • Balance / load cell
Fermentation	• Yield: (fermented pulp weight/ initial pulp -after rasping- weight) * 100 • Temperature monitoring during that unit operation • Water content of the fermented pulp • pH evolution	• Balance / load cell • Embedded temperature sensor • pH-meter
Cooking	• Yield: (cooked product weight measured after the cooked product has cooled/uncooked product weight) * 100 • Temperature monitoring • Manual stirring : number of rotations per minute (rpm)	• Balance / Load cell • Portable acquisition system • Video

4.4. Discussion guideline with processors

- Prior to processing diagnosis, invite processors to observe the 4-6 varieties and give their views on the quality characteristics of each one.
- Use the guidance in Appendix A: “Discussion guideline with processors before, during and after processing” to interview processors before starting the processing diagnosis. Please tailor the guideline as suitable for your product and context.

- Collect all the quality characteristics of each variety, the most liked and the least liked characteristics, using the table in Appendix D: “Quality characteristics of the crop and the final product [under study] required by processors”, and mention the number of citations for each characteristic.
- Varieties proposed by processors in Step 3 may not be the same as mentioned in the interview of Step 2. It does not matter if they are not the same. It is important to collect different varieties with high and low quality characteristics.
- Processing ability of the varieties will be tested, and if the same varieties are mentioned in interview Step 2 and processed in Step 3, it will be interesting to have first of all a list of these characteristics of the raw material and the final product from the Step 2 interviews. After interviewing the processors, you can compare the two lists (Steps 2 & 3). But DO NOT MENTION these characteristics to the processors DURING the processing interview to avoid influencing them.
- The lists of characteristics from Steps 2 and 3 will be used to build the Check all That Apply (CATA) Table and choose Just About Right (JAR) important characteristics for Step 4.
- The questions are a guide for the discussion with processors, and the conversation can be relatively free, taking shape around the emerging topics and themes.
- Take good notes. **Notes should be verbatim – as it is spoken - and not interpretations of the discussion. This is important for high quality – qualitative analysis.** Record the interviews if possible so you can check your notes and transcribe any gaps you may have missed.
- Try not to take your ideas or opinions of responses with you to the discussion. One suggestion is to ensure that the terms and phrases used by processors are not interpreted. For instance, if processors find the variety (raw material) “watery”, and “will give a lower yield of the product” just when they look at or weigh the variety in their hands, please do not write that that variety has a lower dry matter content. Try to better understand, and let biochemists to analyse [crop and product under study] and translate these characteristics (least liked or most liked by processors) into physical and biochemical compounds (such as dry matter content) which will be related later to the technological quality of the crop.
- Importantly, probe and listen to processors without leading them to answer in certain ways. Sometimes it is not easy for them to describe their views on whether the variety will give a high quality product -- to explain why they like that variety, and what details they recognize in advance, before starting processing. Therefore, the facilitator will need to ask questions in different ways, ask to think of comparisons, and go the extra mile to obtain description.
- Critical information to be collected is indicated with an asterisk (*).
- Try to interview a group of 5-8 processors -- those who will be involved in the processing demonstration of the [crop under study].

- **At each step of crop processing into the product**, processors are asked on what details they recognise that the crop (or the intermediate product) will give a high quality product, and how they know if the variety is suitable for that processing. Please refer to the guidance in Appendix A: “Discussion guideline with processors before, during and after processing”.
- Collect all of the quality characteristics of each variety, the most liked and the least liked characteristics, using the table in Appendix D : “Quality characteristics of the crop and the final product required by processors”, and mention the number of citations for each characteristic.
- **At the end of the process**, processors are invited to give separately their views and opinion on each **final product**, and asked to describe its quality characteristics when looking at, touching, smelling, and tasting it. Please refer to the guidance in Appendix A: “Discussion guideline with processors before, during and after processing”.
- Collect all of the quality characteristics of each variety, the most liked and the least liked characteristics, using the table in Appendix D: “Quality characteristics of the crop and the final product required by processors”, and mention the number of citations for each characteristic.
- Probe and listen to processors without leading them to answer in certain ways. Try to understand the terms they cite when describing the quality characteristics. For instance, if a

French speaking processor describes a final product as “doux”, try to understand if “**doux**” means “**sweet**”, or “**soft”** in texture, or “**smooth”** in the mouth (homogeneous), or “**without fibres”** … and write the explanation between brackets beside the term “doux”.

- Finally, processors are invited to describe their **preferences** and asked which [product under study] looks more like the product they usually consume, which one they like and dislike the most, and why.
- Ranking the products in order of preference may be established.

4.5. Gender and demand related research as part of Step 3

Processing diagnoses are an opportunity for the gender specialist and economist to engage with the processors and schedule additional interviews. So as to avoid tiring processors during processing diagnosis, ask if the processors could be interviewed on another day and time convenient to them for additional questions. Even if there is no gender specialist in the team, they should be able to take precise notes from processors’ answers; however, preferably this will be conducted by a gender specialist.

Specific gender-related questions for processors:

- Access to and control over varieties they need/know that make high quality product. Can they access the varieties they prefer? Why or why not? Are there constraints in access (e.g. availability, cost etc), and if so, what and why? If they cannot access these varieties, what do they use and what are the results of this? Can they decide which varieties to plant?
- Labour: are there varieties that increase or decrease their labour burden (e.g. exertion/time in peeling, harvesting, soaking etc.)? What are the varieties and how do they affect labour for what tasks? Can they get access to varieties, which decrease their labour burden? Are there constraints in access? What and why?
- Income: what is their ability to make independent decisions, or to influence another’s decision, on the use of income generated from processing? Who and what influences their decisions, or takes the decisions?
- Market access: what are the opportunities and constraints that they experience in selling their product? Are these opportunities and constraints affected by their gender? (E.g. mobility constraints, access to capital etc.). Do they have plans to expand? Why or why not?
- Foresight analysis: what would they rather be doing if they could? Would they be processing, or another business?

The economist can use the questionnaire developed in the Step 2 manual, and tailor the questions to the appropriate market level, i.e. marketing around town and important processing centres, as opposed to village level marketing as conducted in Step 2.

- A gender-related market question would be nice to add here: if interviewing wholesalers for example, how do they choose the specific processors to buy from? Do they always buy from the same processors? How do they come in contact with these processors? Then you can identify if some of these issues are gender-related or not.

5. DATA ANALYSIS

In order to avoid the loss of information, hand written field data should be transferred to a computer as soon as possible after collection in the community. Take the appropriate data protection measures.

Processing diagnosis will be duplicated for each variety.

Comparison between varieties will be made to evaluate the differences in the processing ability of each variety during each processing unit operation and during the whole process. A ranking of the varieties may be established.

Comparison between processing centres and regions will be possible if the same varieties are processed.

6. APPENDICES

6.1. Appendix A: Discussion guideline with processors before, during and after processing

Facilitator to note:

Date	Name of small town	Language	Interviewer's name

Name	Consent to participate Y/N	Age	Gender	Ethnicity	Education (include categories in national census)	Function in the processing unit

Before starting the processing diagnosis

General questions to each selected processor on her/his processing activity

1. Is the [product under study] you process used only for your or your household's consumption?

2. Is the [product under study] you process sold? If yes:

   2.1. Where do you sell your [product under study]?

   2.2. To whom?

   2.3. What is the proportion (or quantity) of the [product under study] sold as compared to the total quantity of the [product under study] processed daily or weekly or per season? *(You may propose to each processor to determine the proportion using 10 stones).*

3. *Please describe what a high quality **raw** [product under study] looks like in your opinion. *Regarding the appearance, the odour, the texture between fingers, the taste, the texture in the mouth, the aroma*

4. *How do the main quality characteristics of [product under study] differ according to the consumption pattern (e.g. *consumed raw, with water added, cooked into paste)?*

5. Do these quality characteristics have an additional cost? Is the "high quality [product under study]" more expensive? How much more expensive?

6. *Please describe a [product under study] that you would not be able to sell because of its low quality.

   6.1 What are the main reasons that make it a low quality [product under study] (*processing steps, variety, season, environmental effect, harvesting period…*)?

   6.2 What processing steps may have been conducted badly to make a low quality [product under study]? What have you "missed" in the processing?

Before starting the processing diagnosis

When harvesting the selected varieties in the fields in the sample area, or when looking at the selected varieties/genotypes harvested, or bought to a market, or provided by a research station for the participatory study

7. *Among the selected varieties you will process for that participatory study, which variety is your favourite for making the [product under study]? Why?

8. *What are the characteristics of that favourite variety that you notice when you look at the raw material? Are they similar to the characteristics of the variety you normally use for making this [product under study]?

9. *Please give the name of other varieties that make a high quality [product under study] that you like. Why do you like these varieties? How do you recognize them (*visually, by tasting them*)? What is essential for you?

10. *Which variety do you dislike the most among the selected varieties you will process for the participatory study? Why? What are its characteristics when you look at it?
(*Please collect the local name of the variety cited by the processor and if possible scientific name (mainly for banana and yam varieties)*

11. *How do you assess the bad quality of the [crop under study] (raw material) for making the [product under study]?

12. *Which variety would you never buy (or use) to make the [product under study]? Why? Who buys that variety? Why?

During the processing diagnosis, at each step of the process, and for each selected variety

13. *At each step of the process, what are the details that you recognise which indicate that the crop (or the intermediate product) will give a high quality [product under study]?

    → When peeling

    → Washing

    → …

    → …

    → …

    →Cooking

    → …

14. *How do you know that this variety is suitable for this process?

15. *How do you recognise when the final processing step (cooking, or drying, or roasting, or pounding, or boiling…) is finished, and will give a high quality [product under study] that you like?

16. Which of the processing steps may easily alter the quality of the final [product under study]?

17. *Which of the processing steps are most important in effecting the quality of the final [product under study] and require a particular (special) attention?

18. *For the variety which is not suitable at all for making a high quality final [product under study], what would you like to change about this variety?

After processing diagnosis

Evaluation of the final [products under study]

19. *What is your opinion of that [product under study]? What is your first impression just by looking at it? Do you like it? Please explain why. What are the characteristics you like? The characteristics you don't like?

20. *When you touch that [product under study], explain your impression. Do you like it? Describe the way it feels between fingers. What are the characteristics (between fingers) that you like? The characteristics you don't like?

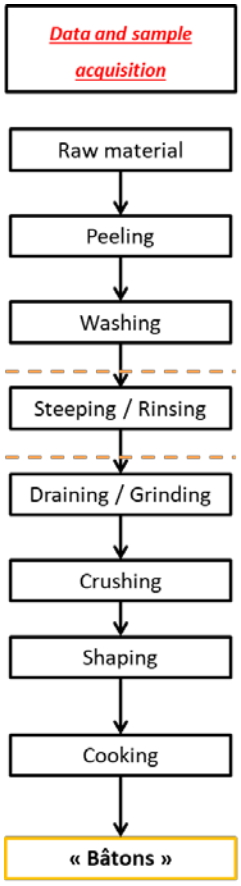
21. *When you taste that [product under study], explain your impression. Do you like it? Describe the way it feels in mouth. What are the characteristics (in mouth) that you like? The characteristics you don't like? What about the taste, the texture in mouth?

The same questions 19 to 22 should be applied one by one to each product made from each variety, before going on to Q.22.

22. *Among these [products under study], which one is your favourite? What are the reasons for this? Rank in order of importance, 1=most important.

23. *Among these [products under study], which one do you like the least? What are the reasons for this? Rank in order of importance, 1=most important.

6.2. Appendix B: Experimental collection data plan (example*)



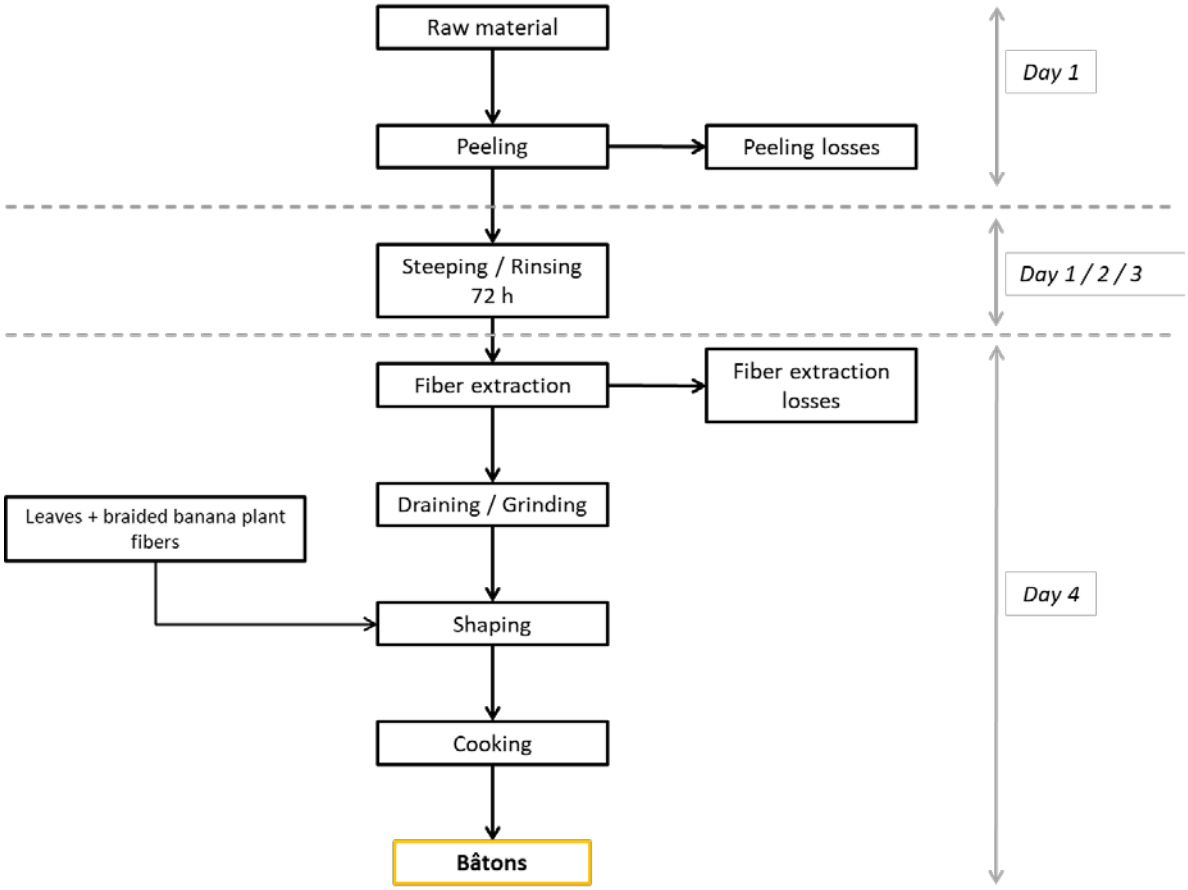
Weight ; material balance	Sample collect / Lab. analyses	Dry matter	Time	Work force	Energy water	Temperature (°C)	pH	dry material soluble loss	Diverse
X m roots		X							Outside and inside root photos
X roots and peel			X	X					Photos
			X	X	X V water				
X Initial weight X final weight	X Water end X Filtred water	X d.m Whatman X pulp	X		X V water		X Final water	X filter Whatman X filtered water	Daily observations with operator advisories Photos
X final weight	X	X	X	X					Pulp taken for France to dryPhotos
X	X crushed pulp		X	X	X (Type of motor)				System characterization principle and dimensions Speed rotation/spacing etcPhotos
X W Leaves X W bâtons	X leaves								Sampling sheets for dryingPhotos
X W end cooking	X cinetic	X	X	X	X weight wood or gaz	X acquisition Almemo X + cooling			System characterization principle and dimensions Number of layers of sticks Photos
X	X								Photos

**Bouniol, A., Prin, L., Hanna, R., Fosto, A. and Fliedel, G., (2017). Assessment of the processability of improved cassava varieties into a traditional food product ("bâton" or "chikwangue") in Cameroon. M'Balmayo (Cameroon). CGIAR Research Program on Roots, Tubers and Bananas (RTB). RTB Working Paper. No. 2012-1.*

6.3. Appendix C: Examples* of diagrams for reporting

Overall diagram (flowsheet) of the process

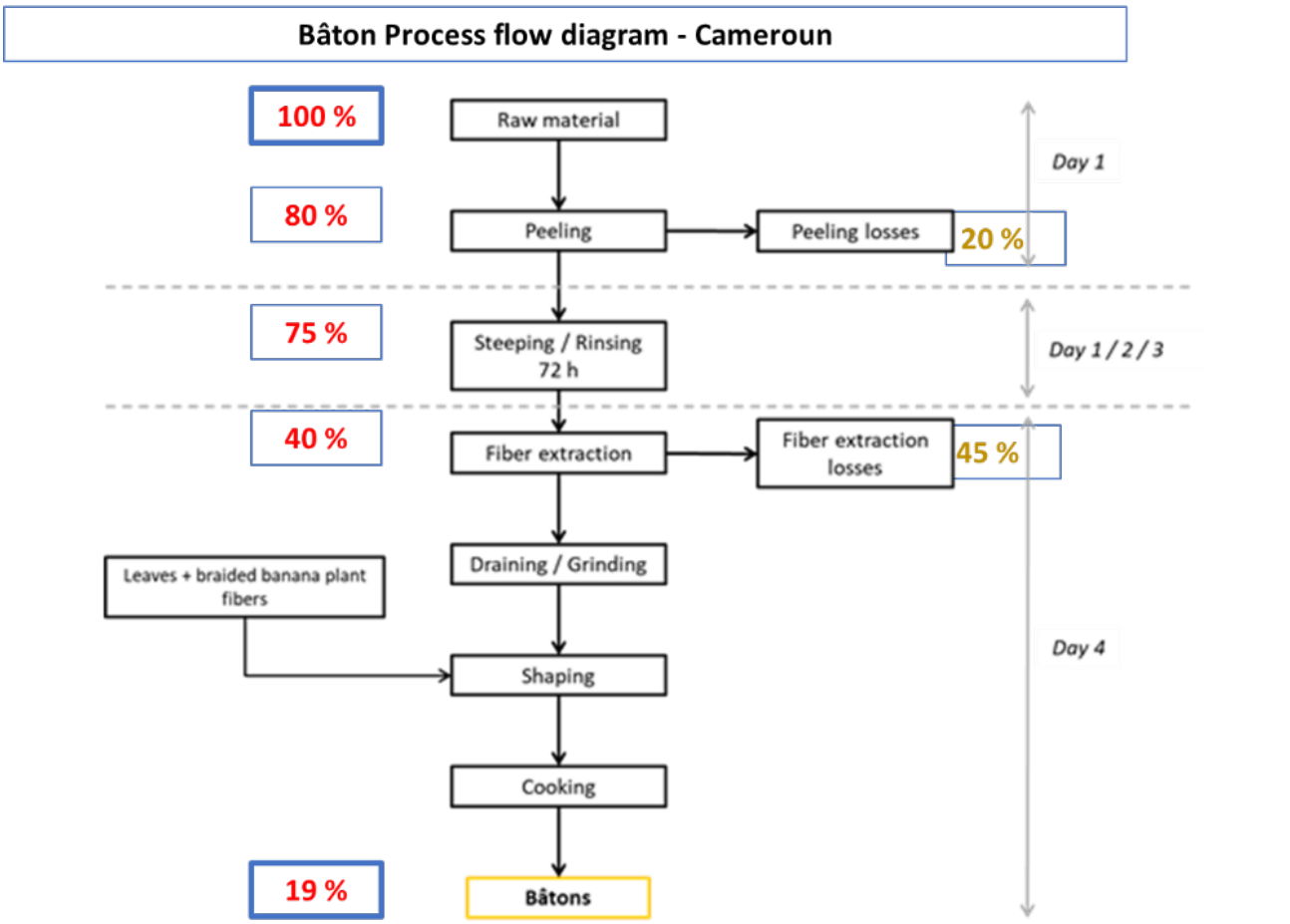
For each [product in the study] in each area sampled (if the process varies, depending on the location), an overall diagram of the process will be established. It will contain the essential information describing the sequence of the different unit operations, duration per unit operation, the different inputs & outputs in the process.



** Bouniol, A., Prin, L., Hanna, R., Fosto, A. and Fliedel, G., (2017). Assessment of the processability of improved cassava varieties into a traditional food product ("bâton" or "chikwangue") in Cameroon. M'Balmayo (Cameroon). CGIAR Research Program on Roots, Tubers and Bananas (RTB). RTB Working Paper. No. 2012-1.*

Flow diagram of the whole process including the material balance

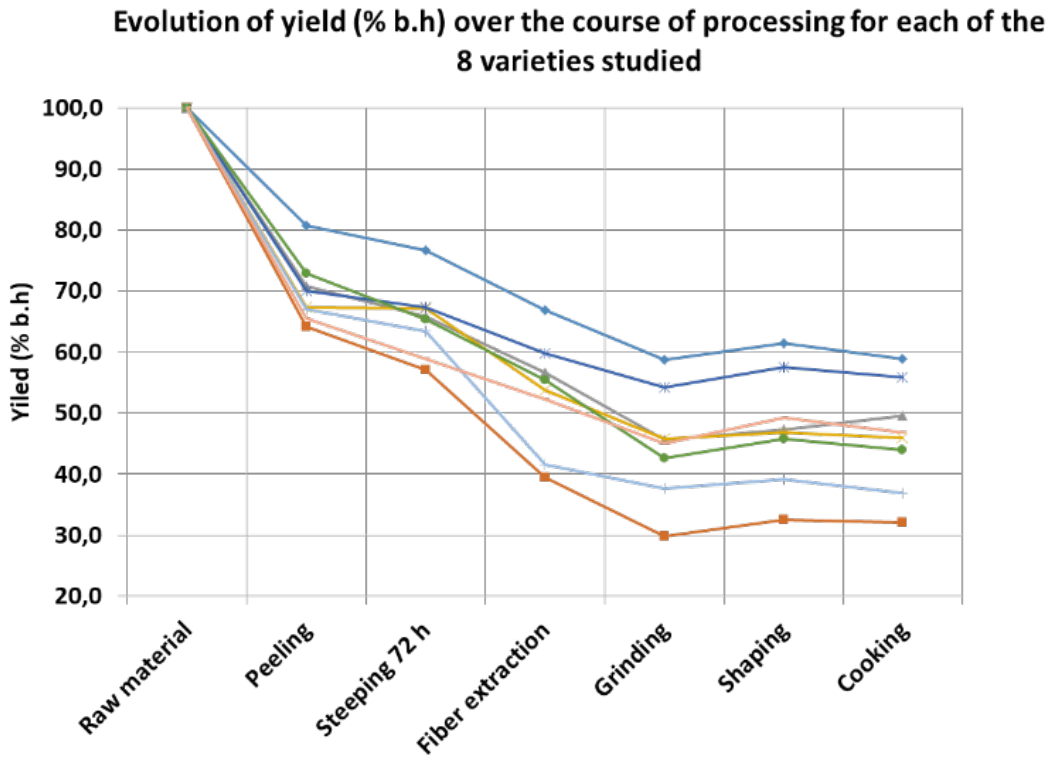
The yield data (wet basis) of the intermediate [product under study] collected at the end of each unit operation makes it possible to express the results in base 100. This has the advantage of being able to quickly read the overall efficiency of the whole process, and then to quickly identify the unit operations having the greatest impact on the processing performance.



Evolution of the yield during the whole process

The evolution of the yield shows the impact of each unit operation on the overall yield of the process. It is particularly interesting to use it to compare the processing ability of each variety.

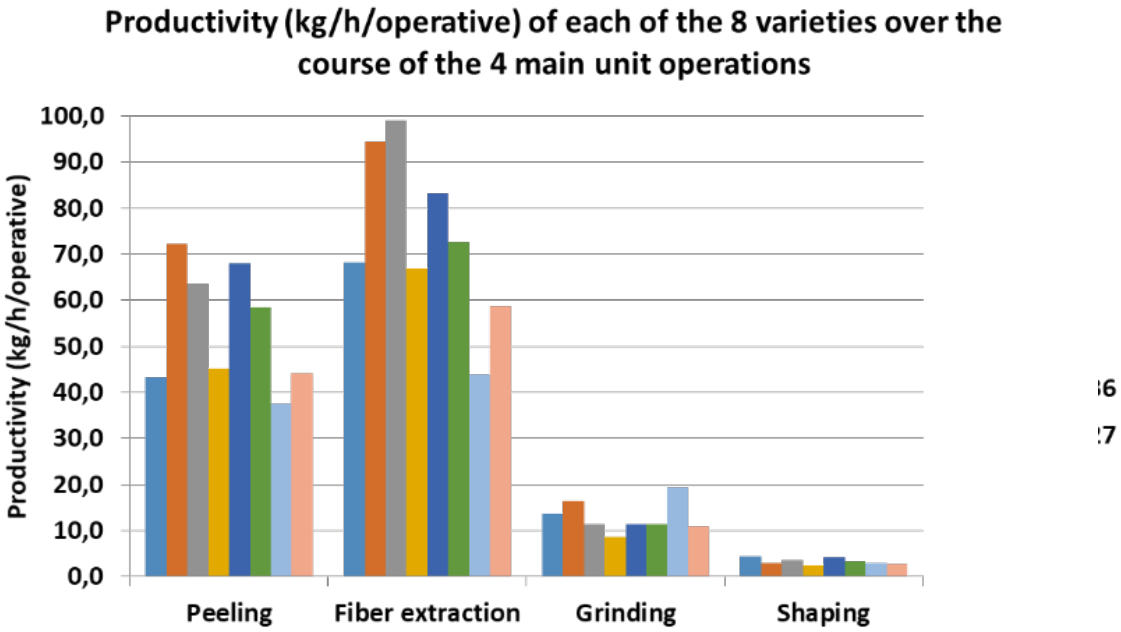
The yield of a [product under study] obtained from the [crop under study] is an important parameter for processors who sell the product. However, a variety which has a slightly lower yield with higher sensory properties can be accepted by processors and consumers.



Evolution of the productivity during the whole process

The evolution of the productivity of the process visualizes the impact of each unit operation on the productivity of the overall process. It is particularly interesting to use it to compare the overall productivity of each variety and to identify limiting unit operations in terms of productivity (bottleneck unit operation).

A variety with high quality characteristics and lower productivity should not be rejected by processors, in particular if it is appreciated by consumers. In that case, processors will try to find solutions for improving the productivity of some unit operations.



Depending on the crop/product process with different unit operations, data may be completed by specific measurements: temperature evolution during a cooking step, temperature and pH during a fermentation step, etc.

The diagnosis and its interpretation may be reinforced by measurements of energy and water consumption if they can be carried out easily in the processing unit.

6.4. Appendix D: Quality characteristics of the crop and the final product [under study] required by processors

	Quality characteristics of the raw material [crop under study]		Quality characteristics of the final [product under study]
	When buying or after harvesting	**At each step of process**	**Raw (or ready to eat) product**
List of **the most liked** characteristics	Appearance - - Odour - - Texture when touching - - Taste when biting - -	First step - - Second step - - Third step - - Fourth step - - Fifth step - -	Appearance - - Odour - - Texture when touching - - Taste - - Texture in mouth - - Aroma Aftertaste
List of the least liked characteristics	Appearance - - Odour - - Texture when touching - - Taste when biting - -	First step - - Second step - - Third step - - Fourth step - - Fifth step - -	Appearance - - Odour - - Texture when Touching - - Taste - - Texture in mouth - - Aroma Aftertaste

- It is advised to fill first of all one table per product in each location and each region (per processed variety).

- At the end of Step 3, it is recommended to fill **a summary table** regrouping all the **quality characteristics** (liked and not liked) of crop and final product cited by processors before, during and after the processing diagnosis, with a **number of citations** per characteristic for each product/variety (between brackets beside each characteristic). A ranking of the most important quality characteristics of the crop and the final product can be established.

- This should help to build the **CATA table** (Step 4 Consumer testing) by regrouping 20-25 terms including sensory and emotional descriptors (liked and not liked) of the 4-5 selected final products, regarding their appearance (colour, shape, size, texture when looking), odour, texture between fingers, taste, texture in mouth, aroma and aftertaste.

- Importantly, the report should include the number of times the quality characteristics were cited in **one location** to compare **across fieldwork sites**.

6.5. Appendix E: Information and consent for interviews

[Name of institution] are currently conducting an introductory study on root, tuber and banana preferences to inform breeding programmes in a project entitled RTBfoods. The aim of the project is to identify the preferred characteristics of [product under study] in [country] among producers, processors, consumers, and other user groups (what makes a high quality product). This interview is part of an initial study interviewing key individuals to gain a better understanding of preferences for the crop, the product, product markets, and the context of these products in people's lives. You were selected for a key informant interview based on your experience and expertise regarding our study.

Importantly, we would also like to identify if preferences for some crop and product characteristics vary geographically and according to processing methods, gender, age, socio-economic status, ethnicity or other factors.

Taking part in this research study is completely voluntary. You may choose not to take part at all. If you decide to be in this study, you may stop participating at any time. You are not under any obligation to answer any questions that you are not comfortable with. Furthermore, because you were selected as for this interview due to your expertise, we would like to include your name and institution on a list of key informants interviewed. However, please let us know if you would like your name to be excluded.

We ensure that all of the information collected in RTBfoods project will be securely managed and stored. We are collecting all the responses from everyone we speak to. All of the information collected during our discussion will not include your name or location and so you cannot be identified.

Please complete the information below if you consent to participating in the interview.

<table>
<tr><td colspan="2">Do you agree to take part in this study?</td><td>YES / NO</td></tr>
<tr><td colspan="2">Signed:</td><td>Date:
……../……../……..</td></tr>
<tr><td rowspan="2">If signed is not possible</td><td>Verbal consent:</td><td>YES / NO</td></tr>
<tr><td colspan="2">Witness's name in block letters:</td></tr>
<tr><td colspan="2">Participant's name in block letters:</td><td></td></tr>
<tr><td colspan="2">Signature of investigator:</td><td>Date:
……../……../……..</td></tr>
</table>

This Project is Supervised by:
Contact Details (including address/email/ telephone number):

6.6. Appendix F: Information et Consentement pour entretiens

Dans le cadre du projet intitulé RTBfoods, le [Nom de l'Institution] conduit actuellement une étude exploratoire sur les préférences des utilisateurs concernant les racines, tubercules et bananes à cuire pour améliorer les programmes de sélection variétale. Le but de ce projet est de caractériser les préférences des producteurs, transformateurs, consommateurs et d'autres groupes d'utilisateurs du [produit concerné] dans le [pays concerné] (qu'est-ce qu'un bon produit). Cette enquête est partie intégrante d'une étude initiale interrogeant des acteurs clés pour acquérir une meilleure compréhension des préférences concernant une matière première, un produit, ses dérivés et le contexte de ces derniers dans le quotidien des populations. Vous avez été sélectionné en tant qu'acteur clé pour une enquête relative à votre expérience et votre expertise concernant notre étude.

Il est à noter que nous souhaitons également identifier si les préférences pour certaines caractéristiques d'une matière première et d'un produit varient en fonction du lieu, des méthodes de transformation, du sexe, de l'âge, du statut socio-économique et ethnique, ou d'autres facteurs.

La participation à cette recherche est totalement volontaire. Vous pouvez choisir de ne pas participer du tout. Si vous décidez de prendre part à cette étude, vous pouvez mettre fin à votre participation à tout moment. Vous n'êtes soumis à aucune obligation pour répondre aux questions avec lesquelles vous n'êtes pas à l'aise. De plus, parce que vous avez été sélectionné en raison de votre expertise, nous souhaiterions pouvoir inclure votre nom et votre institution dans la liste des informateurs clés enquêtés. Cependant, si vous souhaitez que votre nom en soit exclu, n'hésitez pas à nous le faire savoir.

Nous vous assurons que toute l'information collectée dans le cadre du projet RTBfoods sera gérée et conservée de façon sécurisée. Nous collectons les réponses de toutes les personnes avec qui nous nous entretenons. L'information collectée durant les discussions n'inclura ni votre nom ni votre localité. De cette façon, vous ne pouvez pas être identifié.

Veuillez, s'il vous plaît, remplir le formulaire ci-joint si vous consentez à participer à cette enquête.

<table>
<tr><td colspan="2">Consentez-vous à participer à cette étude ?</td><td>OUI / NON</td></tr>
<tr><td colspan="2">Signature:</td><td>Date:
……./……../……..</td></tr>
<tr><td rowspan="2">Si une signature n'est pas possible</td><td colspan="2">Consentement oral : OUI / NON</td></tr>
<tr><td colspan="2">Nom du témoin du consentement

(en caractères d'imprimerie) :</td></tr>
<tr><td colspan="2">Nom du participant (en caractères d'imprimerie) :</td><td></td></tr>
<tr><td colspan="2">Signature de l'enquêteur:</td><td>Date:
……./……../……..</td></tr>
<tr><td colspan="2">Ce projet est coordonné par :</td><td></td></tr>
<tr><td colspan="2">Contact (adresse/email/numéro de téléphone) :</td><td></td></tr>
</table>

Institution: Cirad – UMR QualiSud

Address: C/O Cathy Méjean, TA-B95/15 - 73 rue Jean-François Breton - 34398 MONTPELLIER Cedex 5 - France

Contact Tel: +33 4 67 61 44 31

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